



# DO NO HARM – Maternal, Newborn and Infant Care during COVID-19

© UNICEF/UNI341033/PANJWANI

## Background

The global COVID-19 pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led to substantial consequences on public health systems both directly and indirectly. Over a year into the pandemic, there have been more than 164 million confirmed cases of COVID-19 and more than 3.4 million deaths reported from 216 countries across the globe (1). National governments, international organizations, academia and other stakeholders are developing and updating guidelines to reduce exposure and limit spread to the healthcare providers and the public at large (2).

Between 1-10% of COVID-19 cases are in children (in unvaccinated populations,) and most children have had mild symptoms, a good prognosis and very low mortality rates (3-6). Similarly, the majority of pregnant women experience relatively mild symptoms or remain asymptomatic, but

recent data show an increased risk of maternal morbidity and mortality especially among symptomatic pregnant women with COVID-19, as well as an increased likelihood to deliver preterm and admission of their babies to the neonatal unit (7, 8). These outcomes may be even higher among pregnant women in low and middle income countries (9). This emerging evidence underscores the importance of ensuring quality care during the antenatal and post-partum period.

Disruption of essential services across MNCH has impacted millions of lives around the world. Maintaining quality essential care is critical; data from different qualitative surveys and quantitative analysis suggest access to routine antenatal care, skilled attendants at birth, postnatal and pediatric care, have each declined. Fear of contracting the virus, mis-messaging, myths, lockdown measures, fear of quarantine practices, shifting priorities at primary healthcare level, limited travel, and

## Acknowledgements:

This brief is part of a collaborative project between the International Pediatric Association (IPA) and UNICEF.

### Primary Authors:

Omar Irfan (1), Shabina Ariff (2), Leah Greenspan\* (3), Susan Niermeyer\* (4) Jonathan D. Klein (5, 6), Anne Detjen (7), Zulfiqar A. Bhutta (1,2,6)\*\*

### Contributors:

Gagan Gupta (7), Tedbabe Hailegebriel (7), Patricia Jodrey\* (8), Luwei Pearson (7), Jennifer Requejo (7), Priscilla Idele (9)

(1) SickKids Centre for Global Child Health, Toronto, Canada; (2) The Center of Excellence in Women & Child Health, The Aga Khan University, Karachi, Pakistan; (3) USAID GHSI-III, Social Solutions International, Inc.; (4) USAID Bureau for Global Health, Professor of Pediatrics, University of Colorado School of Medicine and Colorado School of Public Health; (5) University of Illinois at Chicago, Chicago, IL, USA; (6) International Pediatric Association, Geneva, Switzerland; (7) UNICEF, New York, NY, USA; (8) United States Agency for International Development, Washington, DC, USA; (9) UNICEF, Florence, Italy

\*The contents of this brief are the responsibility of the authors and do not reflect the views of the U.S. Agency for International Development (USAID) or the United States Government.

\*\*Corresponding author: Prof Zulfiqar A. Bhutta, Centre for Global Child Health, The Hospital for Sick Children, Toronto, Canada (zulfiqar.bhutta@sickkids.ca)

*This brief is made possible by the generous support of the American people through United States Agency for International Development (USAID) through cooperative agreement GHA-G-00-07-00007. The information provided is not official U.S. government information and does not represent the views or positions of USAID or the U.S. government.*



over-stretched health systems with disrupted supply chains and limited personal protective equipment are the drivers for the changes in service delivery (10).

In addition, it is critical for policymakers to consider the indirect consequences of the pandemic. Experience during the 2014 Ebola outbreaks in Africa demonstrated indirect effects on access and utilization of healthcare as well as socio-economic impacts, which outweighed direct ones (11). A modelling study of COVID-19 effects using the Lives Saved Tool (LiST) estimated that the least severe scenario of reductions in coverage of essential interventions combined with an increase of wasting would result in 253,500 additional child deaths and 12,200 additional maternal deaths over 6 months from reduced coverage of MNCH interventions and increased wasting (12). While there has been some recovery, early and alarming reductions in immunization coverage have occurred in more than 68 countries, affecting approximately 80 million children under the age of one year (13).

The **purpose** of this brief is to summarize current evidence and guidance for maintaining safe and effective care across the spectrum of maternal, newborn and infant care while protecting mother and child and health care providers during COVID-19. Furthermore, we review implications of the principle of “do no harm” for maternal, newborn and infant care delivery during COVID-19, so that this information is conveniently and readily available to clinical and health system policy leaders and stakeholders in countries and communities. Additionally, considerations for safe oxygen delivery as well as key Infection Prevention and Control (IPC) measures at home and in health-care facilities for pregnant women, newborns and children are described in detail later in the brief.

Essential services from antenatal care through delivery and postnatal care save lives and promote good health in mothers and babies, Essential services and quality of care during COVID-19 can only be achieved with clear messaging around IPC, provision of necessary supplies in health care facilities and in communities, strengthened and alternative referral options, and alternate modes of service delivery.

The WHO recommends several strategies to mitigate transmission of COVID-19 in health facilities which are general precautions, and not specific to any of the sections that follow. These include the need to screen and triage for suspected COVID-19, followed by isolation and containment of those diagnosed (14). Hand and respiratory hygiene, use of adequate PPE, environmental disinfection, and safe disposal of harmful waste, spatial distance and adequate ventilation in isolation, waiting and triage areas are all mandatory steps to reduce the risk of transmission. Outpatient care, including antenatal and postnatal health visits should consider using telemedicine as a form of providing care and prioritizing symptomatic patients to minimize requirement for PPE and risks of exposure (15). Community-health workers (CHWs), equipped with PPE and capacitated in IPC can help to maximize community outreach and ensure safety, including for home visits for ANC and PNC.

## Ensuring adequate perinatal care of women and the newborn

### Antenatal care (ANC)

- **Essential services must be maintained to identify mothers and newborns at risk and to minimize COVID related complications**
- **Pregnant women with COVID-19 are at an increased risk of critical illness and death compared to non-pregnant women. However the majority of pregnant women with COVID-19 have mild symptoms.**
- **Universal screening for COVID-19 should be offered to all pregnant women entering a health facility for delivery or undergoing a procedure. Those with symptoms of COVID-19 should be prioritized for testing.**
- **Skilled and respectful care to mothers and newborns at all levels of care can improve outcomes**
- **Psychosocial support with attention to anxiety, depression, and intimate partner violence is critical for all pregnant women — especially during the COVID-19 pandemic**
- **Pregnant women at high risk of exposure to SARS-CoV-2 or severe disease may be vaccinated in consultation with their health care provider**



Maintaining equitable and quality antenatal care (ANC) holds immense significance for a positive pregnancy outcome. WHO recommends eight antenatal contacts and more frequent calls or text message reminders, if feasible, to monitor maternal pregnancy-induced hypertension, HIV, gestational diabetes or other comorbidities. WHO also recommends careful monitoring of pregnant women who have been exposed to confirmed COVID-19 cases, and prioritization of pregnant women with symptoms of COVID-19 for testing as those testing positive may require specialized care.

The initial strategy to mitigate transmission of COVID-19 and adverse pregnancy outcomes includes informing pregnant women of their risks for COVID-19 complications and the warning signs of severe COVID-19. Preventive measures include the need to screen and triage for COVID-19, followed by isolation, containment and treatment of those diagnosed (14). To minimize the risk of acquiring SARS-CoV-2 infection, pregnant women should limit unnecessary interactions with individuals suspected to have been exposed to or infected with SARS-COV-2, including those within their household, as possible. When going out or interacting with others, pregnant women should maintain social distance and avoid crowded spaces, wear a non-medical mask where distancing is not possible and frequently wash their hands. Providers who care for pregnant women should be familiar with guidelines for medical management of COVID-19, including management of COVID-19 in pregnancy (16). Precautionary measures, including infection prevention and control, especially during

procedures such as vaginal and ultrasound examinations, must be ensured at all times.

Pregnant women at high risk of exposure to SARS-CoV-2 (e.g., health workers) or who have comorbidities which add to their risk of severe disease may be vaccinated in consultation with their health care provider. WHO does not recommend discontinuing breastfeeding after vaccination (17).

In addition to the direct effects of COVID-19 it is important to lessen any indirect effects on pregnant women which might make the disruptions due to COVID-19 a bigger challenge. WHO and UNICEF have highlighted the importance of timely access to respectful patient-centered and skilled midwifery, obstetric and neonatal care, as well as psychosocial support for all pregnant women, including those suspected of or confirmed as having COVID-19 (16). Available data and reports point towards an increase of vulnerability and risk factors of violence for women and girls during the pandemic (18). In an interrupted time series assessing the impact of distancing and stay-at-home orders to restrict spread of COVID-19 transmission on socio-economic issues in Bangladeshi women and their families, Hamadani et al (19) documented increase in food insecurity, intimate partner violence, and depression and anxiety amongst women who were mothers or female guardians, compared to data collected 2 years prior to the COVID-19 pandemic.

### **Intrapartum care**

- **All women should have individualized delivery planning and antenatal counselling, especially high-risk cases**
- **It is essential to maintain 24/7 facility-based deliveries with skilled birth attendants and respectful care**
- **The mode of delivery should be determined by the clinical condition of the mother and obstetric indication.**
- **All pregnant women, including those with suspected, probable or confirmed COVID-19, should have access to a companion of choice during labour and childbirth**

Pregnant women with risk factors (such as hypertension, diabetes, obesity, and/or advanced age) should be referred for medical management in designated facilities (20-22). They should be counselled about the potential for severe complications from COVID-19 infection and recommended measures to protect themselves and their families from exposure and transmission. If hospitalization for COVID-19 is indicated during pregnancy, care should be provided in a facility that is equipped with adequate maternal and fetal monitoring. A large population-based study (20), the United Kingdom Obstetric Surveillance System (UKOSS), reported that 25% of hospitalized pregnant women with COVID-19 infection delivered prematurely. Similarly, US CDC reported 12.9% preterm births in COVID-19 infected women, 2.7% higher than the national average (23). All births in the UK study had good prognosis, but two stillbirths were reported with unclear cause of death. The most recent evidence suggests low risk of perinatal transmission when strict infection control measures are present throughout delivery, childbirth and the early neonatal period (24).

It is important to individualize delivery planning and antenatal counselling, especially in high-risk cases. Strict monitoring for danger signs during labour is critical. Having a birth companion is important for the safety and well-being of the woman during labor and childbirth. The WHO Clinical case management of COVID-19 guidance recommends that all pregnant women, including those with suspected, probable or confirmed COVID-19, have access to a companion of choice during labour and childbirth (16). Precautionary measures for companions include wearing masks, maintaining hand hygiene, and staying close to the delivering mother throughout to avoid contamination of others in the delivery site.

Although there is a possibility of airborne transmission of SARS-CoV-2 virus during procedures which might generate aerosols (25), there is mixed evidence regarding aerosol generation during pregnancy and childbirth procedures (26). Other important factors governing transmission of infection include the route and duration of exposure, ventilation, the size of inoculum, and host immunity (27).

## Newborn care

- **SARS-CoV-2 infection in neonates is rare, and, if infected, the majority of newborn infants have either asymptomatic or mild disease with good prognosis**
- **Mothers, regardless of COVID-19 status, should not be separated from their infants unless they are too unwell to provide care**
- **The benefits of human milk outweigh any theoretical risk of infection. WHO recommends mothers with suspected or confirmed COVID-19 initiate breastfeeding within 1 hour of birth, wearing medical masks and practicing hand hygiene**
- **All newborn health care providers must be trained in recognizing newborn danger signs and should consider COVID-19 infection as part of differential diagnoses**
- **Pulse oximetry screening and safe use of oxygen are important considerations for small or sick newborns, including those suspected of COVID-19**

The newborn period, infancy, and the first year of life are the most vulnerable time for child survival (28). While the majority of neonates with COVID-19 have either asymptomatic or mild disease, reported transmission in the postnatal period most commonly occurs through the mothers' respiratory secretions (29, 30). WHO recommends mothers with suspected or confirmed COVID-19 not be separated from their newborns and early and uninterrupted skin-to-skin contact be facilitated and encouraged as soon as possible after birth with appropriate IPC measures (16, 31). Mothers should be counselled that the benefits of breastfeeding substantially outweigh the potential risk of COVID-19 transmission. Women with confirmed or suspected COVID-19 should wear a medical mask during contact with the baby, including while feeding. While 8-10 studies showed the presence of SARS-CoV-2 RNA in breastmilk, active COVID-19 (virus that can cause infection) has not, to date, been detected in the breastmilk of any mother with confirmed/suspected COVID-19. It appears unlikely, therefore, that COVID-19 would be transmitted through breastfeeding or by giving breastmilk that has been expressed by a mother who is confirmed/suspected to have COVID-19 (32, 33).

Accumulating experience from registries of neonatal outcomes also supports the safety of breastfeeding (NPC-19 Registry [my.visme.co/view/ojq9qq8e-npc-19-registry](http://my.visme.co/view/ojq9qq8e-npc-19-registry)). In situations where a mother is separated from caring for her infant or from continuing direct breastfeeding due to illness, she should be encouraged to express milk if possible. Other options that can be explored for ill mothers include donor human milk. It is also important for mothers with suspected or confirmed COVID-19 to practice hand hygiene with soap and water or alcohol-based hand rub, especially before contact with her child. Mothers of infants who require specialized hospital-based care should be allowed free access to the baby, with appropriate infection prevention control (IPC) measures.

### Postnatal care (PNC)

- **PNC services for mothers and newborns should be maintained, while also incorporating IPC measures, including proper hand washing, wearing masks, and maintaining physical distance**
- **Postnatal visits and examination of the newborn should follow WHO guidelines on danger signs, weight monitoring and feeding**
- **Innovative approaches to delivery of PNC should include telemedicine, digital platforms, mobile health applications and safe community outreach**
- **The mother's mental health and well-being should be evaluated along with recognizing signs of illness and ensuring care seeking, provision of micronutrient supplementation, counselling on lactation, contraceptives, healthy environment, screening and support for intimate partner violence and healthy diet during post-partum period**
- **All mothers should receive emotional and practical support to enable them to initiate and establish breastfeeding**

Essential postnatal care is important for maximizing health and meeting the needs of both the mother and the newborn during this critical phase of their lives. All mothers should receive practical support to enable them to initiate and establish breastfeeding and manage common breastfeeding difficulties. Appropriately trained health care professionals and

community-based lay and peer breastfeeding counsellors should provide this support, adhering to IPC measures. Depending on the available resources and existing policy, a public health nurse, CHW or a midwife can continue the postpartum care in the community. In order to provide consistent high-quality services across the continuum of care, alternative methods of delivery such as digital platforms and home health visits may need to be explored (15). Digital platforms can include clinical consultations through video chats or telephones, e-pharmacies, helplines, mobile health applications, text messaging, and email. Routine postnatal visits in health facilities could be potentially replaced with postnatal counselling and use of alternative platforms such as home-based visits or telemedicine (2, 34).

### Child Health

- **Essential services for children and adolescents include promotion of health and nutrition, monitoring of growth, timely immunization, management of common illnesses such as pneumonia, diarrhea, and vaccine-preventable diseases, management of malnutrition, and treatment of chronic illnesses**
- **The benefits of continuing immunization far outweigh the excess risk of COVID-19 associated with exposure during vaccination visits**
- **CHWs can be equipped and trained on use of PPE and IPC to maximize community outreach and community-based care, including provision of medicines and counselling**
- **It is important to maintain uninterrupted nurturing care in healthcare facilities and in communities, including management of common childhood illnesses, evaluation of and adequate support for child abuse and violence, adequate nutrition, and support to caregivers to provide responsive care.**

Essential services for child and adolescent health encompass promotion of health and nutrition, monitoring of growth, timely immunization, management of common illnesses such as pneumonia, diarrhea, malaria, and vaccine-preventable diseases,

management of malnutrition, measures that support parents to provide nurturing care and enhance early child development, and prevention and treatment of chronic illnesses (35). Interruptions in these services and COVID-19 containment measures can impede implementation of best practices for child health. A full review of recommendations for child and adolescent health are beyond the scope of this brief, but there should not be disruption in the provision of routine well or sick child care, and adequate IPC protocols should be maintained. Evidence-based guidelines and resources to address and implement services to manage these issues are available from WHO, UNICEF, and professional societies (36-40).

## Safe Use of Oxygen and COVID-19

- **Hypoxemia is present in certain newborn and pediatric conditions including respiratory distress syndrome and asphyxia as well as in acute lower respiratory tract infections. Hypoxemia is also a common complication of COVID-19 pneumonia**
- **Safe use of oxygen is essential to do no harm**
- **Pulse oximeters are required for accurate diagnosis and safe treatment of hypoxemia**
- **Oxygen supplementation can result in harmful consequences if delivered in too high concentration or via inappropriate delivery method**

Oxygen is an essential treatment for certain neonatal conditions and severe pneumonia with hypoxemia in children. Hypoxemia is also a common complication in COVID-19 pneumonia with damage to lung cells leading to fluid accumulation, inflammation, and hyaline membrane formation (41), which eventually may cause hypoxia and respiratory failure (42). Safe use of oxygen is imperative in preventing hypoxemia-related deaths. Thus, it is crucial that all primary, secondary and tertiary facilities that provide care to pregnant women, newborns and children, including those with COVID-19, have systems to ensure reliable, uninterrupted oxygen supply, disposable, single-use oxygen delivery interfaces (including nasal cannulas, continuous positive airway pressure

(CPAP) devices, Venturi masks, and masks with reservoir bags), pulse oximeters for triage and to monitor oxygenation levels, healthcare providers (HCPs) trained in safe oxygen administration, and biomedical support staff to maintain oxygen delivery equipment (16). While not essential for low flow delivery, humidification of administered oxygen helps preserve ciliary function, which allows more effective gas exchange and improves comfort (43).

WHO recommends oxygen supplementation in children with severe COVID-19. Emergency indications include: obstructed or absent breathing, severe respiratory distress, central cyanosis, shock, coma, or convulsions) or SpO<sub>2</sub> < 90%, even in the absence of emergency signs (16). Resuscitation with airway management and oxygen therapy should be administered to achieve a target SpO<sub>2</sub> of 90% or more in children. Oxygen should be delivered by nasal prongs or cannula in young children as these devices may be better tolerated, as opposed to masks. Respiratory support for pregnant women with COVID-19 is similar to the general population with fetal wellbeing to be taken into consideration as well. An SpO<sub>2</sub> of 94% is targeted in pregnant women with high flow nasal oxygen (HFNO) preferred if the targeted SpO<sub>2</sub> is not maintained (44). For both pregnant women and children, a trial of HFNO and other non-invasive ventilation methods including CPAP and bi-level positive airway pressure (BiPAP) are useful in management of COVID-19 and mild acute respiratory distress syndrome (ARDS).

Clinicians can identify hypoxemia from clinical signs, or through invasive (arterial blood gases) and non-invasive (pulse oximetry) methods. However, clinical signs alone may not always predict onset of hypoxemia and recognition of signs is subject to the health care provider's skills (45). More objective diagnostic tools such as pulse oximetry are required for accurate and prompt diagnosis of hypoxemia. In addition, a proportion of COVID-19 patients do not present with any signs or symptoms of distress, a phenomenon termed 'silent' or 'happy' hypoxemia, thus relying solely on clinical signs can result in misdiagnosis of these patients (46).



© UNICEF/UN0270632/NAH OORSOUW

Pulse oximeters measure the percentage of oxygenated haemoglobin in arterial blood and are an accurate, cost-effective, non-invasive means of identifying and monitoring hypoxemia (47). Compared to clinical signs alone, pulse oximetry can identify hypoxemia accurately in 20–30% more children (48). Children with hypoxemia must be observed closely for signs of clinical deterioration such as rapidly progressive respiratory failure, poor oxygen intake and shock (16, 49). In case of established hypoxemic respiratory failure, hemodynamic instability, multi-organ failure, or abnormal mental status, the use of invasive ventilation is recommended (50).

Oxygen supplementation can harm patients when those requiring oxygen are incorrectly identified, or when oxygen delivery is too high or variable and monitoring is inadequate. Preterm infants are often exposed to high concentrations of oxygen for long periods of time leading to development of bronchopulmonary dysplasia (BPD) or retinopathy of prematurity (ROP). Aside from the inherent risks associated

with high oxygen supplementation, use of inappropriate delivery methods such as dry and cold oxygen or low-quality methods of securing oxygen (e.g., tape not suitable for newborn skin) can also cause harm regardless of age.

Increased investments in oxygen systems as part of the COVID-19 response are an opportunity to increase access to oxygen and build capacity in oxygen therapy for newborns and children. In the long-term, this will help safely treat the many causes of hypoxemia in children.

### **Infection Prevention and Control (IPC)**

Basic infection prevention and control (IPC) measures should always be in place in all health facilities and in the context of community-based health care. Additional and strengthened IPC measures are recommended by WHO in the context of COVID-19 (14). Countries with limited resources

for IPC are asked to maintain at least the minimum requirements for IPC developed by WHO (51) to provide the minimum required protection to HCWs and patients.

COVID-19 IPC care protocols for pregnant mothers are similar to those for general patients. WHO has put forward five IPC strategies to prevent transmission of COVID-19 in health facilities (14):

1. Early recognition of patients suspected with COVID-19 through screening and triage followed by rapid isolation to contain transmission (52). The recommendations for isolation rooms is that the space should be clean, away from mainstream clinical areas with good ventilation and physical distancing.
2. Standard precautions always need to be maintained. WHO recommends cleaning hands according to the WHO's 5 moments for hand hygiene.
3. Patients in different categories should be isolated separately, as either being suspected or confirmed

to have COVID-19. This can be achieved by designating separate rooms and healthcare teams for the different cohorts. The equipment used in these rooms should be kept separate, must be single-use or disinfected each time if used on another patient (53). It is important to maintain physical distancing, screening and triage, one-way patient flow and other precautionary protocols in care facilities and in-patient care units to reduce transmission. The presence of family or an attendant should always include proper use of PPE. Children in isolation require child-friendly, nurturing care and spaces. If possible, a caregiver should accompany children. The family, if separated from the newborn, may also need additional psychosocial and emotional support.

4. There must be a focus on protective measures related to HCWs, which includes adequate training on up-to-date COVID-19 definitions and protocols, adjusting schedules to minimize overcrowding, staggering cafeteria meals to ensure physical distancing and ensuring HCW compliance to precautionary measures.



©UNICEF ETHIOPIA/2020/TEWODROS TADESSE



5. Adequate environment cleaning, spatial distance and ventilation are needed to significantly reduce spread of infectious pathogens (54, 55).

It is important for HCWs, including CHWs to adopt a rational use of PPE, including masks, in order to maintain efficacy and avoid shortages of supplies. Community based health care requires adherence to IPC protocols including in the context of child health and immunization services (56).

### **General considerations for safe care delivery during the COVID-19 Pandemic**

It is important for the HCPs and HCWs to ensure strict adherence to IPC protocols in all care settings. Many countries are facing health workforce challenges, including shortages, maldistribution and misalignment between population health needs and health worker competencies. Adopting telehealth modalities is a potentially successful strategy to reduce the risk of SARS-CoV-2 transmission in healthcare settings while maintaining high quality patient care. At facilities, patients should be advised to put on face coverings before entering the facility, follow triage procedures, and maintain physical distancing when possible. HCPs should wear a face-mask at all times while in a healthcare facility. HCPs entering a room of a patient with suspected or confirmed SARS-CoV-2 infection should make use of face masks, gown, gloves, and eye protection, and should perform hand hygiene before and after all patient contact.

When performing potential aerosol-generating procedures including administration of supplemental oxygen and bag-mask ventilation, High-flow and CPAP, tracheal intubation, tracheostomy and manual ventilation prior to intubation, airborne precautions should be used, including use of N95 masks and face shields if available, in addition to contact precautions to prevent risk of SARS-CoV-2 transmission (57). Only necessary personnel should be in the room when performing these procedures. Particulate respirators (N-95 masks or equivalent) should be properly fitted, seal checked prior to use, and wherever possible, procedures must be performed in rooms



with negative pressure ventilation with a minimum of 12 air changes per hour or at least 160 L/second/patient in facilities with natural ventilation. A recent systematic review did not identify any studies that directly reported on the risk of aerosolization with HFNO use in COVID-19 infection (58).

## **Conclusions**

The COVID-19 pandemic has served to amplify the basic needs and priorities for high quality, respectful, universal care. Throughout the MNCH continuum, it remains key to 1) strengthen investments in care, especially around the time of birth and the first week of life; 2) improve the quality of care throughout the MNCH continuum and across all levels of the health system, including at community level; 3) expand quality services for small and sick newborns; 4) reduce any inequities in accordance with the principles of universal health coverage (UHC), including in humanitarian and vulnerable settings; 5) promote the



engagement and empowerment of mothers, families and communities to participate in and demand quality care; and 6) strengthen measurement and accountability to count every birth, death and stillbirth.

SARS-CoV-2 may not affect most newborns and children directly as most have mild disease with rare

complications, however, increased disease severity has been observed in pregnant women suffering from COVID-19 compared to non-pregnant women. Interruptions in essential pregnancy, neonatal, postnatal and pediatric healthcare services due to COVID-19 may result in inadvertent harm to children as well as to their mothers. These disruptions can occur due to efforts to contain the outbreak, including self-isolation and lock-down measures, delayed vaccination schedules, interruption of programs for community engagement and behavior change, decreased health-seeking behavior for fear of infection, and financial instability. Adequate, appropriate, and safe MNCH health care delivery can be achieved by maintaining essential elements of high-quality care in combination with IPC measures. Contextual and diverse strategies using alternate technologies, including digital technologies, can be instituted to ensure continuity of care. Much is still to be learned about direct and indirect impacts of COVID-19 on patients, healthcare providers and the health system. Scale up and safe implementation of oxygen systems, maintenance of essential services through innovative approaches and quality respectful maternal and newborn care are emerging as positive effects of the COVID-19 pandemic.



## References

1. WHO. Coronavirus Disease (COVID-19) Dashboard 21th February 2021. <https://covid19.who.int/>.
2. WHO. Maintaining essential health services: operational guidance for the COVID-19 context interim guidance. World Health Organization, 1 June 2020. <https://www.who.int/publications/item/WHO-2019-nCoV-essential-health-services-2020.1>
3. Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, et al. Epidemiology of COVID-19 among children in China. *Pediatrics*. 2020;145(6).
4. Guan W-j, Ni Z-y, Hu Y, Liang W-h, Ou C-q, He J-x, et al. Clinical characteristics of coronavirus disease 2019 in China. *New England Journal of Medicine*. 2020;382(18):1708-20.
5. AAP. Children and COVID-19: State-Level Data Report 10 Sept 2020. <https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report/>.
6. Irfan O, Muttalib F, Tang K, Jiang L, Lassi ZS, Bhutta Z. Clinical characteristics, treatment and outcomes of paediatric COVID-19: a systematic review and meta-analysis. *Archives of Disease in Childhood*. 2021 Feb 16.
7. Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. *BMJ* 2020; 370:m3320.
8. Allotey J, Stallings E, Bonet M, Yap M, Chatterjee S, Kew T et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. *BMJ* 2020; 370:m3320.
9. Lassi Z, Ali A, Das J, Salam R, Irfan O, Bhutta Z. A systematic analysis of pregnant women with COVID-19: clinical presentation, and pregnancy and neonatal outcomes as per COVID-19 severity. *Systematic Review in progress*. PROSPERO 2020 CRD42020182048 Available from: [https://www.crd.york.ac.uk/prospero/display\\_record.php?ID=CRD42020182048](https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020182048).
10. Akseer N, Kandru G, Keats EC, Bhutta ZA. COVID-19 pandemic and mitigation strategies: implications for maternal and child health and nutrition. *The American Journal of Clinical Nutrition*. 2020;112(2):251-6.
11. Elston J, Cartwright C, Ndumbi P, Wright J. The health impact of the 2014–15 Ebola outbreak. *Public Health*. 2017;143:60-70.
12. Robertson T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam Y, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *The Lancet Global Health*. 2020;8(7):e901-e8.
13. WHO. At least 80 million children under one at risk of diseases such as diphtheria, measles and polio as COVID-19 disrupts routine vaccination efforts, warn Gavi, WHO and UNICEF. [Online] <https://www.who.int/news/item/22-05-2020-at-least-80-million-children-under-one-at-risk-of-diseases-such-as-diphtheria-measles-and-polio-as-covid-19-disrupts-routine-vaccination-efforts-warn-gavi-who-and-unicef>. 2020.
14. WHO. Infection prevention and control during health care when coronavirus diseases (COVID-19) is suspected or confirmed: interim guidance, 29 June 2020 Geneva: World Health Organization; 2020 Available from: <https://www.who.int/publications/item/WHO-2019-nCoV-IPC-2020.4>.
15. WHO. Telemedicine: opportunities and developments in member states. Report on the second global survey on eHealth: World Health Organization; 2010.
16. WHO. COVID-19 Clinical management: living guidance. World Health Organization, 2021. <https://www.who.int/publications/item/WHO-2019-nCoV-clinical-2021-1>
17. WHO. Coronavirus Disease (COVID-19): Vaccine Safety. World Health Organization, 2021. [https://www.who.int/news-room/q-a-detail/coronavirus-disease-\(covid-19\)-vaccines-safety](https://www.who.int/news-room/q-a-detail/coronavirus-disease-(covid-19)-vaccines-safety).
18. UN Women. Impact of COVID-19 on violence against women and girls and service provision: UN Women rapid assessment and findings. <https://www.unwomen.org/-/MEDIA/HEADQUARTERS/ATTACHMENTS/SECTIONS/LIBRARY/PUBLICATIONS/2020/IMPACT-OF-COVID-19-ON-VIOLENCE-AGAINST-WOMEN-AND-GIRLS-AND-SERVICE-PROVISION-EN.PDF?LA=EN&VS=0>.
19. Hamadani JD, Hasan MI, Baldi AJ, Hossain SJ, Shiraji S, Bhuiyan MSA, et al. Immediate impact of stay-at-home orders to control COVID-19 transmission on socioeconomic conditions, food insecurity, mental health, and intimate partner violence in Bangladeshi women and their families: an interrupted time series. *The Lancet Global Health*. 2020;8(11):e1380-e9.
20. Knight M, Bunch K, Vousden N, Morris E, Simpson N, Gale C, et al. Characteristics and outcomes of pregnant women admitted to hospital with confirmed SARS-CoV-2 infection in UK: national population based cohort study. *bmj*. 2020;369.
21. Ellington S, Strid P, Tong VT, Woodworth K, Galang RR, Zambrano LD, et al. Characteristics of women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status—United States, January 22–June 7, 2020. *Morbidity and Mortality Weekly Report*. 2020;69(25):769.
22. Collin J, Byström E, Carnahan A, Ahrne M. Public Health Agency of Sweden's Brief Report: Pregnant and postpartum women with severe acute respiratory syndrome coronavirus 2 infection in intensive care in Sweden. *Acta Obstet Gynecol Scand*. 2020;99(7):819-22.
23. Woodworth KR, Olsen EOM, Neelam V, Lewis EL, Galang RR, Oduyebo T, et al. Birth and infant outcomes following laboratory-confirmed SARS-CoV-2 infection in pregnancy—SET-NET, 16 jurisdictions, March 29–October 14, 2020. *Morbidity and Mortality Weekly Report*. 2020;69(44):1635.
24. Salvatore CM, Han J-Y, Acker KP, Tiwari P, Jin J, Brandler M, et al. Neonatal management and outcomes during the COVID-19 pandemic: an observation cohort study. *The Lancet Child & Adolescent Health*. 2020;4(10):721-7.
25. WHO. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations: scientific brief, 27 March 2020. World Health Organization, 2020.
26. López M, Gonce A, Meler E, Plaza A, Hernández S, Martínez-Portilla RJ, et al. Coronavirus disease 2019 in pregnancy: a clinical management protocol and considerations for practice. *Fetal Diagnosis and Therapy*. 2020;47(7):519-28.
27. Klompas M, Baker MA, Rhee C. Airborne transmission of SARS-CoV-2: theoretical considerations and available evidence. *JAMA*. 2020 Aug 4.
28. Oza S, Cousens SN, Lawn JE. Estimation of daily risk of neonatal death, including the day of birth, in 186 countries in 2013: a vital-registration and modelling-based study. *The Lancet Global Health*. 2014;2(11):e635-e44.
29. Dumitriu D, Emeruwa UN, Hanft E, Liao GV, Ludwig E, Walzer L, et al. Outcomes of neonates born to mothers with severe acute respiratory syndrome coronavirus 2 infection at a large medical center in New York City. *JAMA Pediatrics*. 2020 Oct 12.

30. Blumberg DA, Underwood MA, Hedriana HL, Lakshminrusimha S. Vertical transmission of SARS-CoV-2: what is the optimal definition? *American Journal of Perinatology*. 2020;37(8):769.
31. Sankar MJ, Sinha B, Chowdhury R, Bhandari N, Taneja S, Martinez J, et al. Optimal breastfeeding practices and infant and child mortality: a systematic review and meta-analysis. *Acta Paediatrica*. 2015;104:3-13.
32. WHO. Frequently Asked Questions: Breastfeeding and COVID-19 For health care workers. World Health Organization, 2020 [https://www.who.int/docs/default-source/reproductive-health/maternal-health/faqs-breastfeeding-and-covid-19.pdf?sfvrsn=d839e6c0\\_5](https://www.who.int/docs/default-source/reproductive-health/maternal-health/faqs-breastfeeding-and-covid-19.pdf?sfvrsn=d839e6c0_5).
33. Johns Hopkins Center for Humanitarian Health. COVID-19, Breastfeeding, Infant Feeding, and Breast Milk. <http://hopkinshumanitarianhealth.org/empower/advocacy/covid-19/covid-19-children-and-nutrition/covid-19-breastfeeding-infant-feeding-and-breast-milk/>.
34. WHO. WHO Guideline: recommendations on digital interventions for health system strengthening. World Health Organization, 2019. <https://www.who.int/reproductivehealth/publications/digital-interventions-health-system-strengthening/en/>.
35. WHO. Continuing essential Sexual Reproductive Maternal, Neonatal, Child and Adolescent Health services during COVID-19 pandemic: practical considerations. 2020. <https://apps.who.int/iris/handle/10665/331816>
36. UNICEF. Protecting the most vulnerable children from the impact of coronavirus: an agenda for action. April 3rd. 2020.
37. Richardson D, Carraro A, Cebotari V, Gromada A, Rees G. Supporting Families and Children Beyond COVID-19: Social protection in high-income countries. UNICEF, 2020.
38. WHO. Coronavirus disease (COVID-19): Schools. 18 September 2020 | Q&A. <https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-schools>.
39. UNICEF. Child protection and COVID-19. January 2021. <https://data.unicef.org/topic/child-protection/covid-19/>.
40. WHO. WHO and UNICEF warn of a decline in vaccinations during COVID-19. Available on <https://www.who.int/news/item/15-07-2020-who-and-unicef-warn-of-a-decline-in-vaccinations-during-covid-19>. 2020.
41. Yi Y, Lagniton PN, Ye S, Li E, Xu R-H. COVID-19: what has been learned and to be learned about the novel coronavirus disease. *International Journal of Biological Sciences*. 2020;16(10):1753.
42. Komorowski M, Aberegg SK. Using applied lung physiology to understand COVID-19 patterns. *British Journal of Anaesthesia*. 2020;125(3):250-3.
43. Hasani A, Chapman T, McCool D, Smith R, Dilworth J, Agnew J. Domiciliary humidification improves lung mucociliary clearance in patients with bronchiectasis. *Chronic Respiratory Disease*. 2008;5(2):81-6.
44. Pacheco LD, Saad AF, Saade G. Early acute respiratory support for pregnant patients with coronavirus disease 2019 (COVID-19) infection. *Obstetrics and Gynecology*. 2020 Jul 1.
45. Lodha R, Bhaduria PS, Kuttikat AV, Puranik M, Gupta S, Pandey R, et al. Can clinical symptoms or signs accurately predict hypoxemia in children with acute lower respiratory tract infections? *Indian Pediatrics*. 2004;41(2):129-36.
46. Dhont S, Derom E, Van Braeckel E, Depuydt P, Lambrecht BN. The pathophysiology of 'happy' hypoxemia in COVID-19. *Respiratory Research*. 2020;21(1):1-9.
47. WHO. WHO-UNICEF technical specifications and guidance for oxygen therapy devices. World Health Organization; 2019. [https://www.who.int/medical\\_devices/publications/tech\\_specs\\_oxygen\\_therapy\\_devices/en/](https://www.who.int/medical_devices/publications/tech_specs_oxygen_therapy_devices/en/)
48. Duke T, Blaschke A, Sialis S, Bonkowsky J. Hypoxaemia in acute respiratory and non-respiratory illnesses in neonates and children in a developing country. *Archives of Disease in Childhood*. 2002;86(2):108-12.
49. WHO. Oxygen therapy for children. A manual for health workers. WHO 2016. <https://www.who.int/publications/item/9789241549554>.
50. Ozyilmaz E, Ugurlu AO, Nava S. Timing of noninvasive ventilation failure: causes, risk factors, and potential remedies. *BMC Pulmonary Medicine*. 2014;14(1):19.
51. WHO. Minimum requirements for infection prevention and control. Geneva: World Health Organization; 2019. <https://www.who.int/infection-prevention/publications/core-components/en/>
52. WHO. Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages: interim guidance, 6 April 2020. World Health Organization, 2020. [https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-\(covid-19\)-and-considerations-during-severe-shortages](https://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages)
53. WHO. Cleaning and disinfection of environmental surfaces in the context of COVID-19: interim guidance, 15 May 2020. World Health Organization, 2020. <https://www.who.int/publications/i/item/cleaning-and-disinfection-of-environmental-surfaces-in-the-context-of-covid-19>
54. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. *The Lancet*. 2020;395(10242):1973-87.
55. Jefferson T, Foxlee R, Del Mar C, Dooley L, Ferroni E, Hewak B, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review. *BMJ*. 2008;336(7635):77-80.
56. WHO, UNICEF, IFRC. Community-based health care, including outreach and campaigns, in the context of the COVID-19 pandemic: interim guidance, May 2020. World Health Organization, 2020. [https://www.who.int/publications/i/item/WHO-2019-nCoV-Comm\\_health\\_care-2020.1](https://www.who.int/publications/i/item/WHO-2019-nCoV-Comm_health_care-2020.1)
57. WHO. Mask use in the context of COVID-19. World Health Organization, 2020. [https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-\(2019-ncov\)-outbreak](https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak).
58. Agarwal A, Basmaji J, Muttalib F, Granton D, Chaudhuri D, Chetan D, et al. High-flow nasal cannula for acute hypoxemic respiratory failure in patients with COVID-19: systematic reviews of effectiveness and its risks of aerosolization, dispersion, and infection transmission. *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*. 2020;67(9):1217-48.